the ia7301B Computer in a Book

SYSTEM SERVICE MANUAL

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Foreword

This service manual has been prepared to provide you with technical information on the ia7301 Computer in a Book. Should you decide to modify, trouble shoot, or disassemble your system, be extremely careful not to invalidate your warranty (see below). We also recommend that you do not attempt to work on the ia7301 microcomputer system until you have completed the entire course materials.

We have gathered all necessary drawings, schematics, and parts lists in this manual for your convenience. We have also included a board layout diagram for you to identify the actual components on the microcomputer board from the schematic references.

Since improvements are made from time to time in any microcomputer system, we will be revising this manual at the time when a significant number of changes have been made. These changes and improvements will only affect new systems. So to assist you in keeping manuals together with the right microcomputer system, we have indicated the serial number of your system for this manual at the bottom of the page.

Lastly, we have tried to catch all the modifications and corrections to make this service manual as accurate and useful as possible. If by chance you find technical errors in this manual please let us know so that we can let all the ia7301 users have the benefit of your findings.

YOUR 90 DAY FULL WARRANTY
ON ALL IASIS PRODUCTS

Your Entro products have been properly designed, carefully assembled and thoroughly tested, before they were shipped to you. We've gone to great lengths using the best in quality components and workmanship to give you reliable, full performance in accordance with our instruction manuals.

All Entro products are guaranteed to be free from defects in materials, components and workmanship for 90 days from the date of sale to only the original purchaser. During this warranty period, Iasis Inc., will replace or repair at its option as soon as practical any items which are found to be defective in our judgement under the conditions of this warranty.

Our warranty, both expressed and implied, does not cover damage or malfunction caused by misuse, customer modification or repairs, incorrect operation or assembly, accident, neglect, use of corrosive solder, or force majeure. Nor does this warranty extend to Iasis systems repaired by unauthorized agencies, or where the serial numbers have been altered, removed or defaced.

This warranty does not cover reimbursements for customer assembly time or set up time; and is not extended to non-Iasis equipment or components used in conjunction with our products or any damage as a result thereof.

Serial No. ____________________

Fig. 1 CPU Schematic Diagram

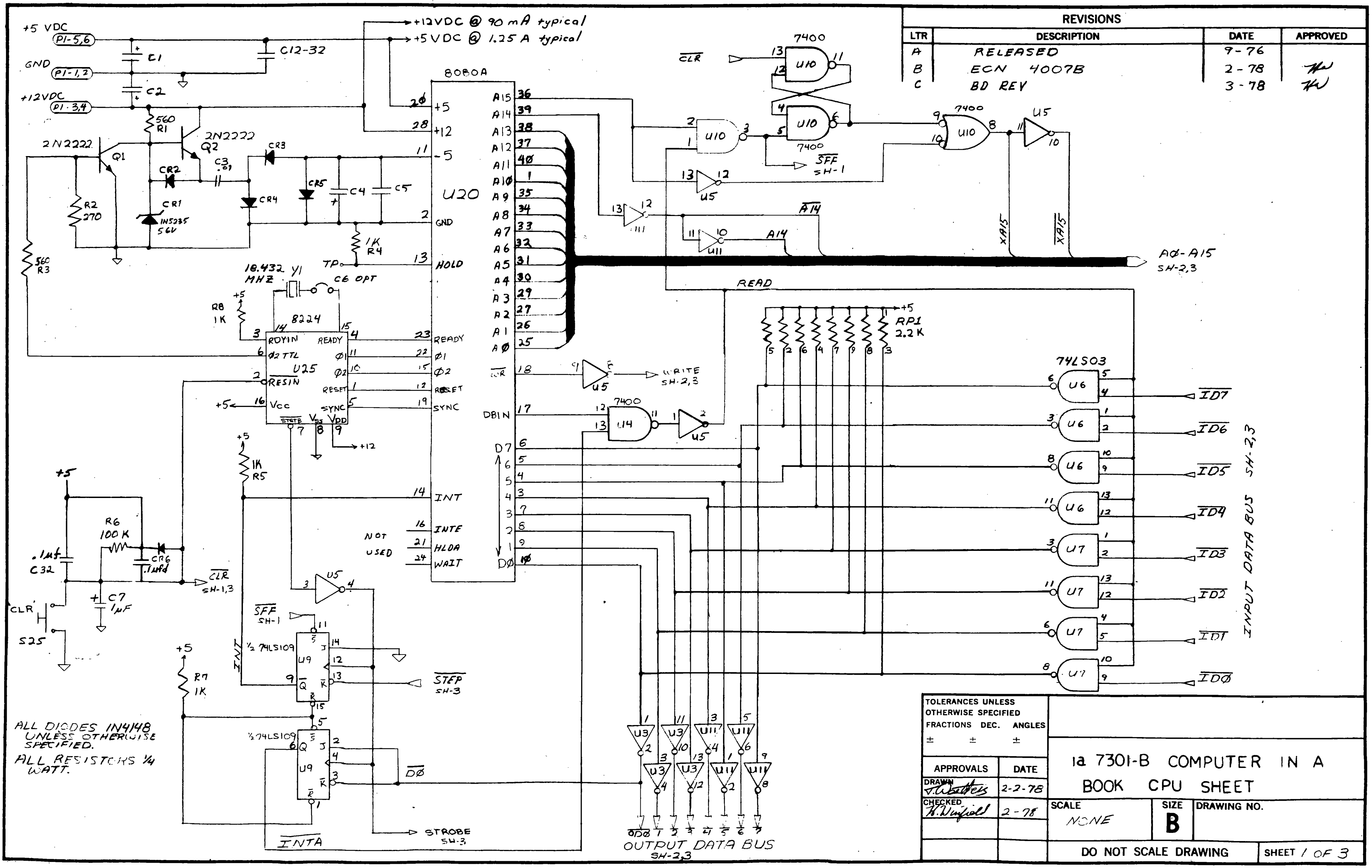
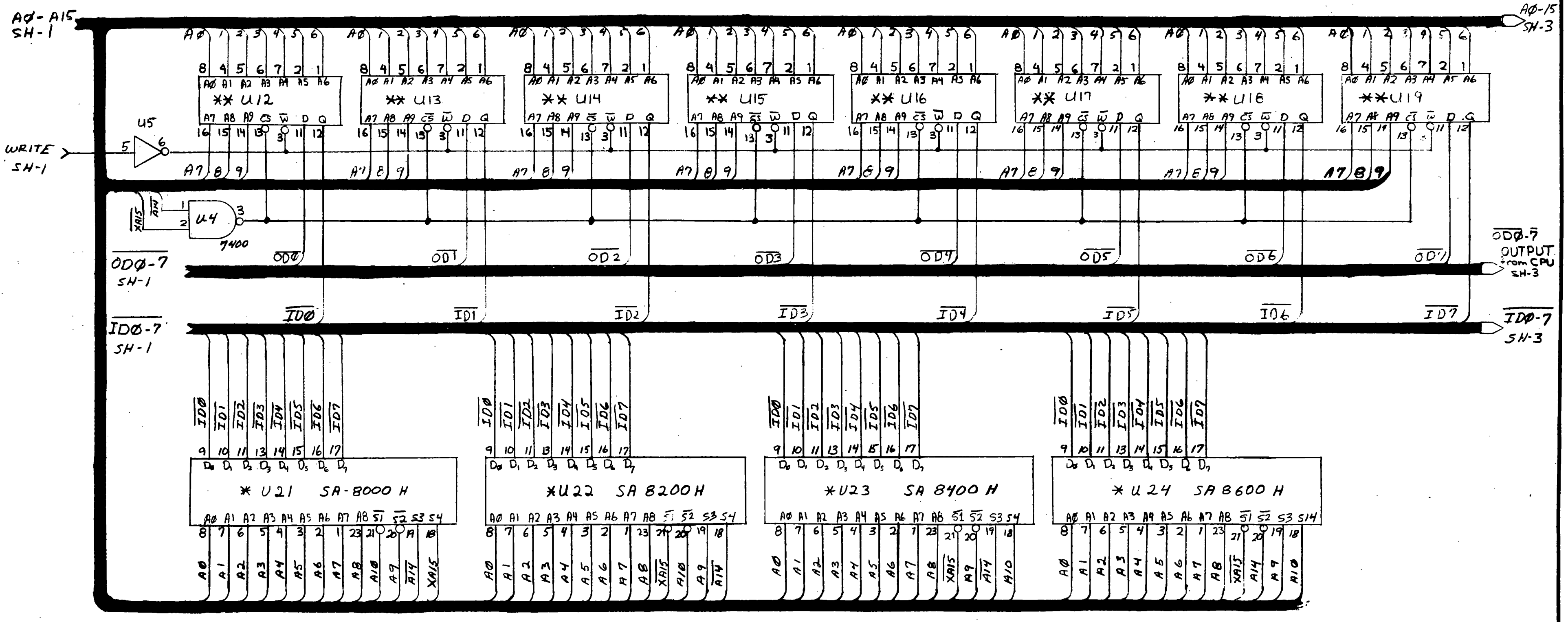


Fig. 2 Memory Schematic Diagram

REVISIONS			
LTR	DESCRIPTION	DATE	APPROVED
A	RELEASED	9-76	
B	ECN 4007B	2-78	
C	BD REV	3-78	



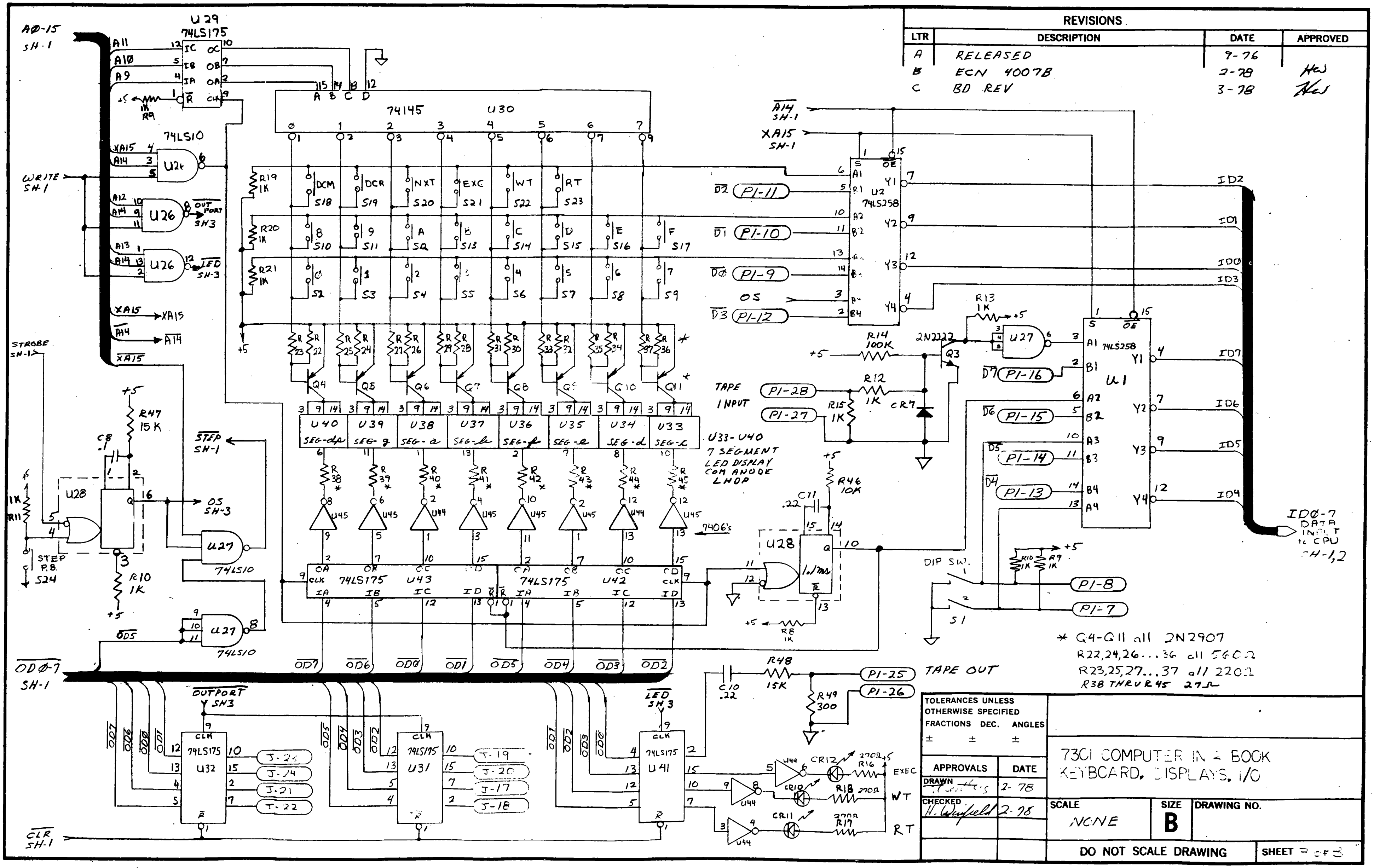
* NOTE

1. U21 IS 512X8 PROM PRGM 'A'
2. U22 IS 512X8 PROM PRGM 'B'
3. U23, U24 PRGM OPTION SOCKETS BOTH ARE 512X8

** U12 THRU U19 ARE 2102A-4
VCC - PIN 10
GND - PIN 9

TOLERANCES UNLESS OTHERWISE SPECIFIED FRACTIONS ± DEC. ± ANGLES ±		
APPROVALS	DATE	7301 COMPUTER IN A BOOK MEMORY
DRAWN T.C. Watters	1-13-76	
CHECKED H. Winfield	2-78	SCALE NONE · SIZE B · DRAWING NO.
		DO NOT SCALE DRAWING · SHEET 2 OF 3

Fig. 3 I/O Schematic Diagram



LTR	DESCRIPTION	DATE	APPROVED
A	RELEASED	9-76	
B	ECN 4007B	2-78	HW
C	BD REV	3-78	HW

TOLERANCES UNLESS OTHERWISE SPECIFIED
FRACTIONS ± DEC. ± ANGLES ±

APPROVALS | DATE
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7301 COMPUTER IN A BOOK
KEYBOARD, DISPLAYS, I/O

SCALE NONE
SIZE B
DRAWING NO.
DO NOT SCALE DRAWING
SHEET 2 OF 3

Fig. 4 Component Layout Sheet

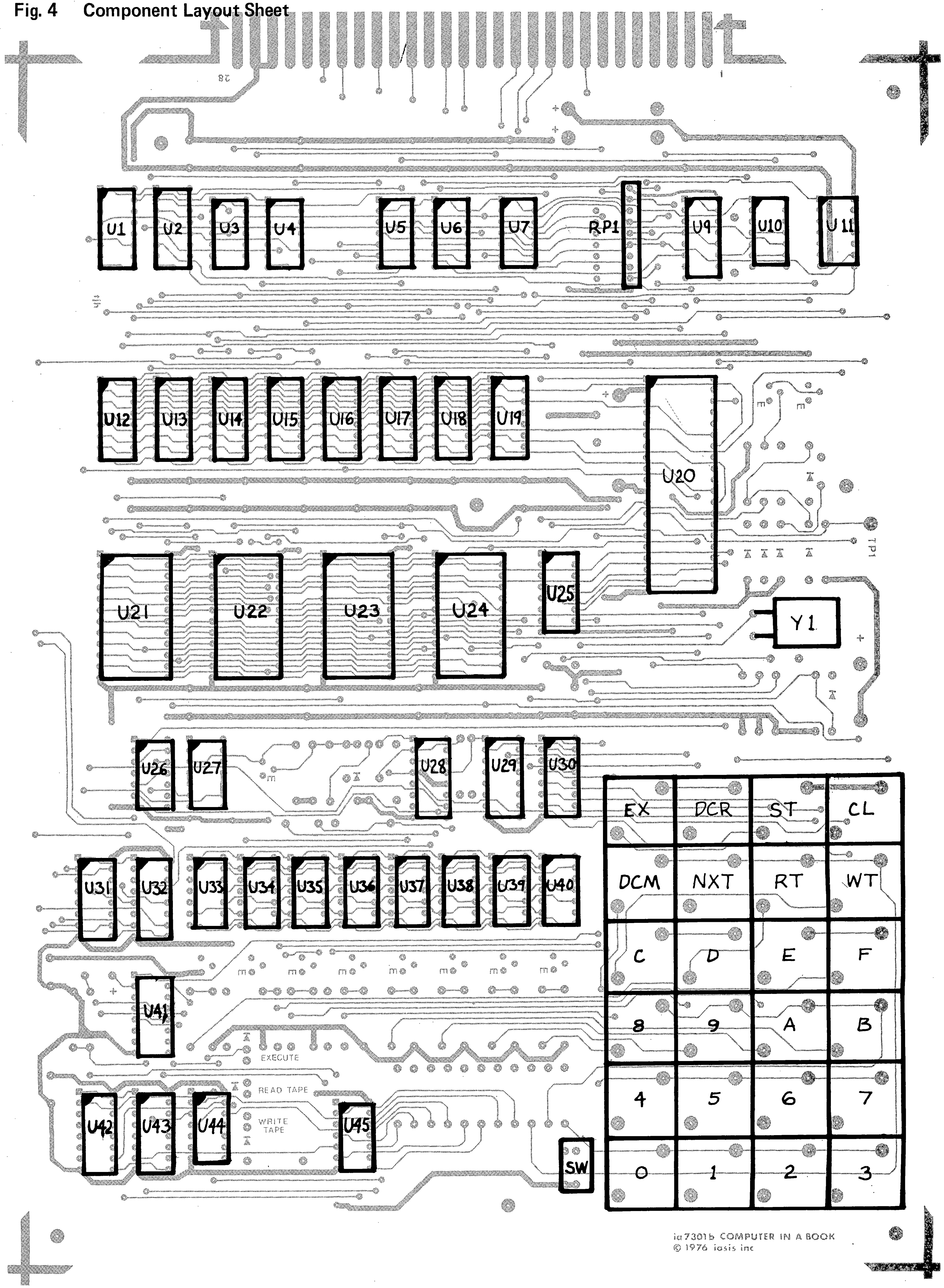

Fig. 5 Component Layout Schedule

TRANSISTORS

Q1	2N2222
Q2	"
Q3	"
Q4	2N2907
Q5	"
Q6	"
Q7	"
Q8	"
Q9	"
Q10	"
Q11	"

DIODES

CR1	1N5235
CR2	1N4148
CR3	"
CR4	"
CR5	"
CR6	"
CR7	"
CR8	N.R.
CR9	N.R.
CR10	LED
CR11	LED
CR12	LED

CAPACITORS

C1	8.2 ufd, 20V
C2	"
C3	10 ufd, 10V
C4	.01 ufd
C5	"
C6	"
C7	"
C8	"
C9	"
C10	"
C11	"
C12	"
C13	"
C14	"
C15	"
C16	"
C17	"
C18	"
C19	"
C20	"
C21	8.2 ufd, 20V
C22	"
C23	"
C24	"
C25	"
C26	"
C27	"
C28	"
C29	"
C30	1 ufd
C31	.22 ufd
C32	.01 ufd
C33	.22 ufd
C34	.01 ufd

RESISTORS

R1	560 OHM
R2	270
R3	560
R4	1K
R5	1K
R6	100K
R7	1K
R8	1K
R9	1K
R10	1K
R11	1K
R12	1K
R13	1k
R14	100K
R15	1K
R16	270
R17	270
R18	270
R19	1K
R20	1K
R21	1K
R22	560
R23	220
R24	560
R25	220
R26	560
R27	220
R28	560
R29	220
R30	560
R31	220
R32	560
R33	220
R34	560
R35	220
R36	560
R37	220
R38	560
R39	220
R40	27
R41	27
R42	27
R43	27
R44	27
R45	27
R46	10K
R47	15K
R48	15K
R49	300
R50	1K
R51	1K

SEMICONDUCTORS

U1	74LS258
U2	"
U3	7404
U4	7400
U5	7404
U6	74LS03
U7	"
U8	
U9	74LS109
U10	7400
U11	7404
U12	2102
U13	"
U14	"
U15	"
U16	"
U17	"
U18	"
U19	"
U20	8080A
U21	PROM
U22	PROM
U23	PROM
U24	PROM
U25	8224
U26	74LS10
U27	"
U28	9602
U29	74LS175
U30	74145
U31	74LS175
U32	"
U33	7 SEG Display
U34	"
U35	"
U36	"
U37	"
U38	"
U39	"
U40	"
U41	74LS175
U42	"
U43	"
U44	7406
U45	7406

Fig. 6 PC Board Layout, Component Side

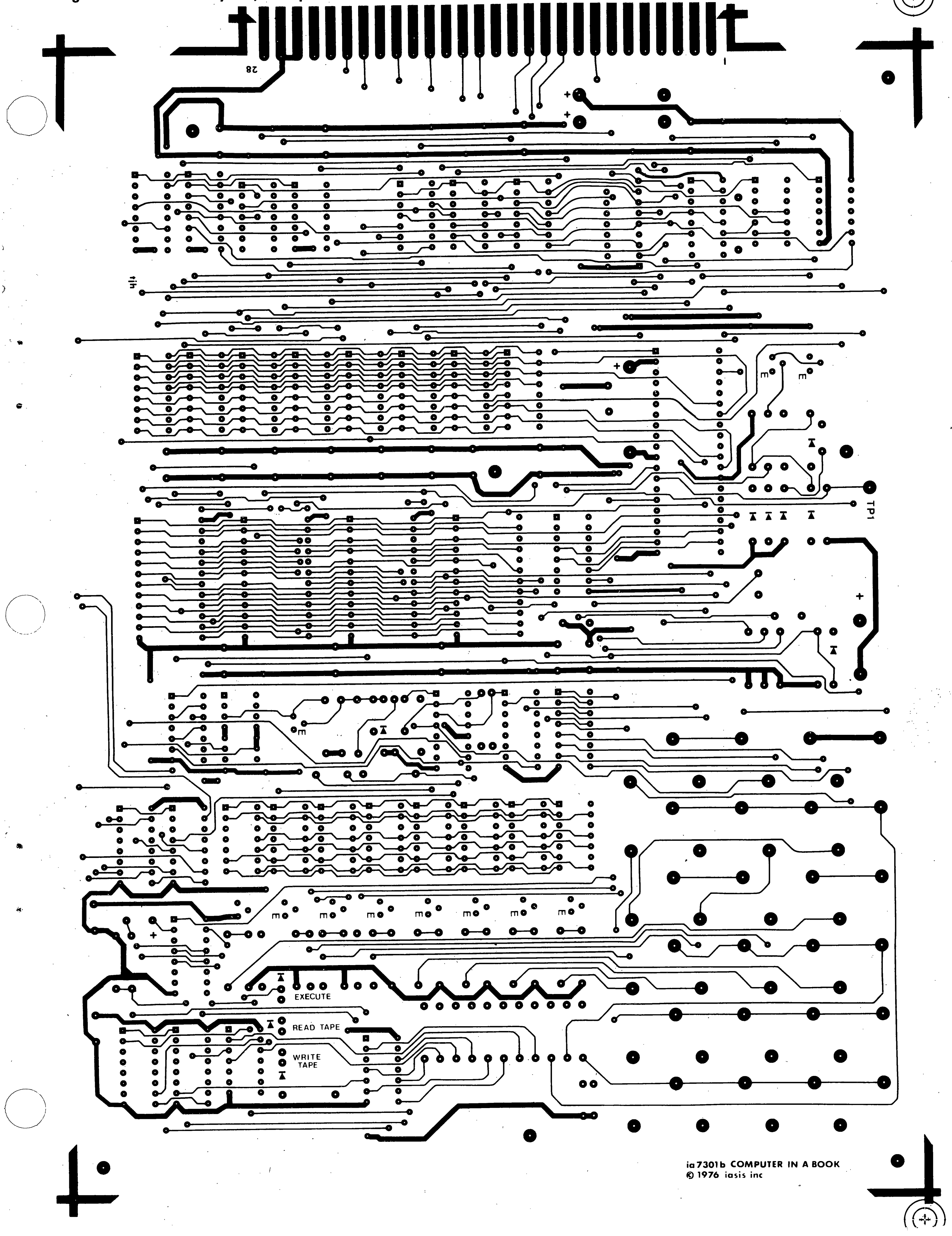

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Fig. 7 PC Board Layout, Non-Component Side

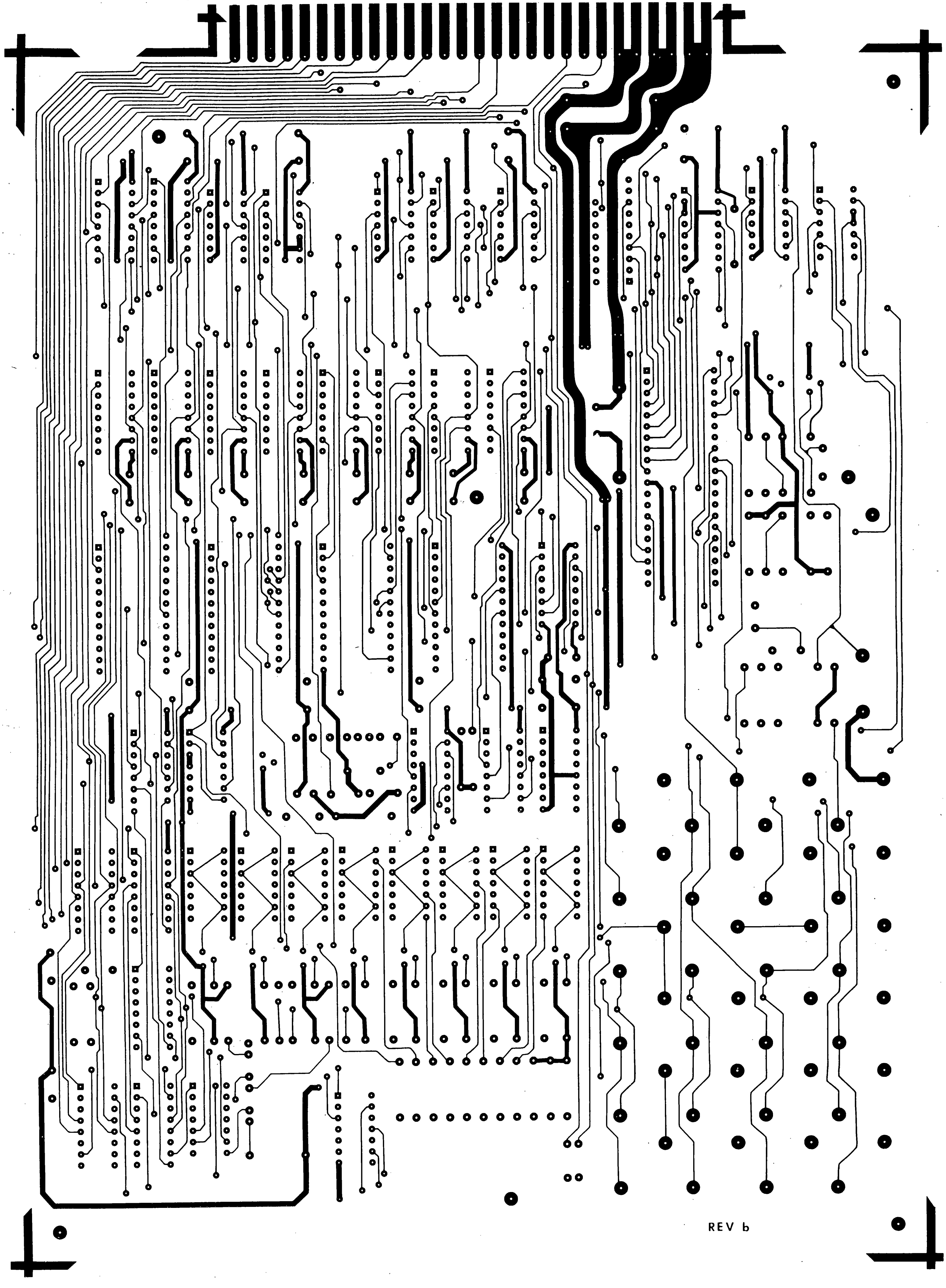
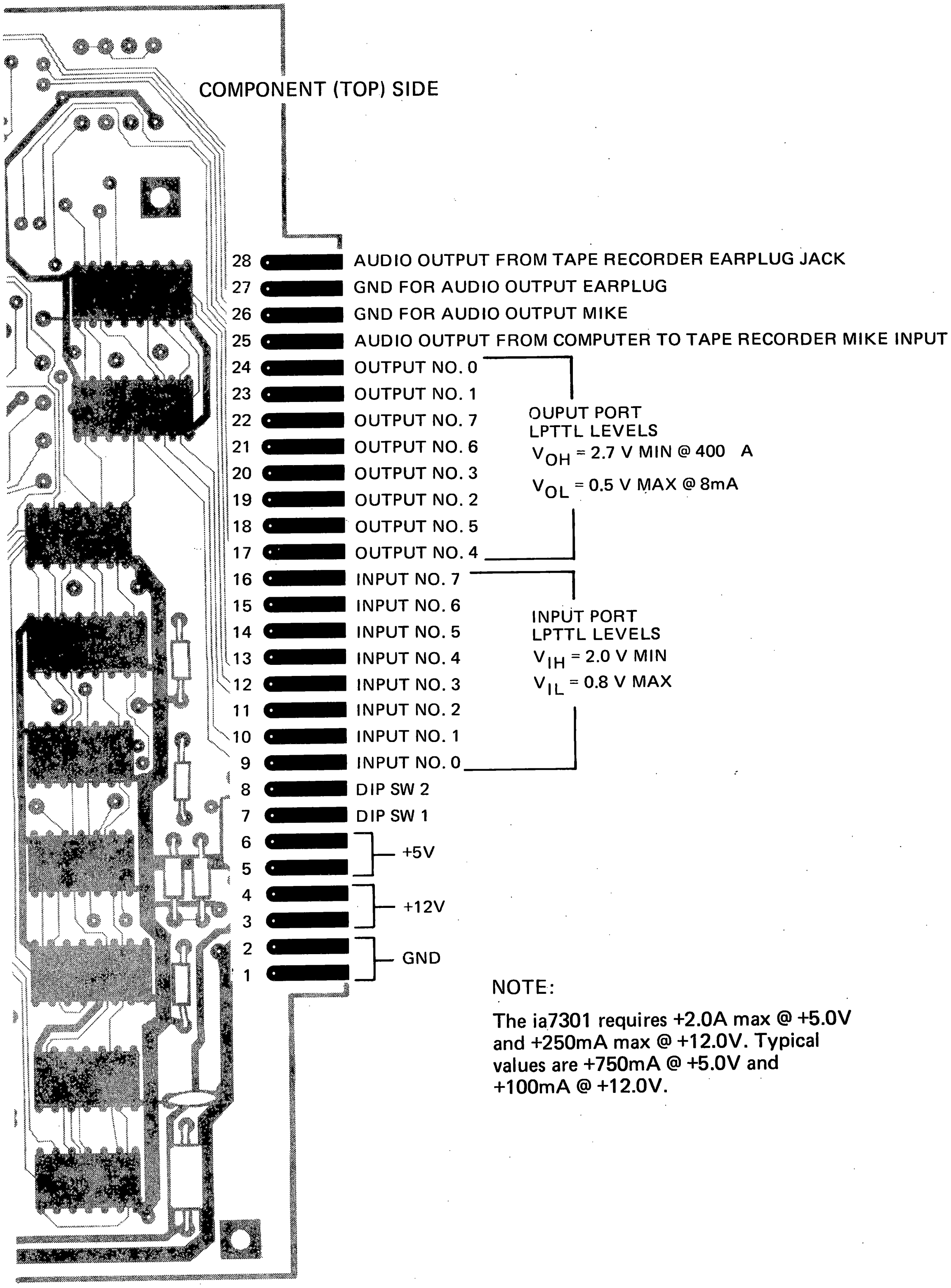


Fig. 8 Edge Connector Pin-Outs



NOTE:

The ia7301 requires +2.0A max @ +5.0V and +250mA max @ +12.0V. Typical values are +750mA @ +5.0V and +100mA @ +12.0V.

Fig. 9 8080 Instruction Set

HEX	MNEMONIC
00	NOP
01	LXI B,D16
02	STAX B
03	INX B
04	INR B
05	DCR B
06	MVI B,D8
07	RLC
08	- - -
09	DAD B
0A	LDAX B
0B	DCX B
0C	INR C
0D	DCR C
0E	MVI C,D8
0F	RRC
10	- - -
11	LXI D,D16
12	STAX D
13	INX D
14	INR D
15	DCR D
16	MVI D,D8
17	RAL
18	- - -
19	DAD D
1A	LDAX D
1B	DCX D
1C	INR E
1D	DCR E
1E	MVI E,D8
1F	RAR
20	- - -
21	LXI H,D16
22	SHLD Adr
23	INX H
24	INR H
25	DCR H
26	MVI H,D8
27	DAA
28	- - -
29	DAD H
2A	LHLD Adr
2B	DCX H
2C	INR L
2D	DCR L
2E	MVI L,D8
2F	CMA
30	- - -
31	LXI SP,D16
32	STA Adr
33	INX SP
34	INR M
35	DCR M
36	MVI M,D8
37	STC
38	- - -
39	DAD SP
3A	LDA Adr
3B	DCX SP
3C	INR A
3D	DCR A
3E	MVI A,D8
3F	CMC
40	MOV B,B
41	MOV B,C
42	MOV B,D
43	MOV B,E
44	MOV B,H
45	MOV B,L
46	MOV B,M
47	MOV B,A
48	MOV C,B
49	MOV C,C
4A	MOV C,D
4B	MOV C,E
4C	MOV C,H
4D	MOV C,L
4E	MOV C,M
4F	MOV C,A
50	MOV D,B
51	MOV D,C
52	MOV D,D
53	MOV D,E
54	MOV D,H
55	MOV D,L
56	MOV D,M
57	MOV D,A
58	MOV E,B
59	MOV E,C
5A	MOV E,D
5B	MOV E,E
5C	MOV E,H
5D	MOV E,L
5E	MOV E,M
5F	MOV E,A
60	MOV H,B
61	MOV H,C
62	MOV H,D
63	MOV H,E
64	MOV H,H
65	MOV H,L
66	MOV H,M
67	MOV H,A
68	MOV L,B
69	MOV L,C
6A	MOV L,D
6B	MOV L,E
6C	MOV L,H
6D	MOV L,L
6E	MOV L,M
6F	MOV L,A
70	MOV M,B
71	MOV M,C
72	MOV M,D
73	MOV M,E
74	MOV M,H
75	MOV M,L
76	HLT
77	MOV M,A
78	MOV A,B
79	MOV A,C
7A	MOV A,D
7B	MOV A,E
7C	MOV A,H
7D	MOV A,L
7E	MOV A,M
7F	MOV A,A
80	ADD B
81	ADD C
82	ADD D
83	ADD E
84	ADD H
85	ADD L
86	ADD M
87	ADD A
88	ADC B
89	ADC C
8A	ADC D
8B	ADC E
8C	ADC H
8D	ADC L
8E	ADC M
8F	ADC A
90	SUB B
91	SUB C
92	SUB D
93	SUB E
94	SUB H
95	SUB L
96	SUB M
97	SUB A
98	SBB B
99	SBB C
9A	SBB D
9B	SBB E
9C	SBB H
9D	SBB L
9E	SBB M
9F	SBB A
A0	ANA B
A1	ANA C
A2	ANA D
A3	ANA E
A4	ANA H
A5	ANA L
A6	ANA M
A7	ANA A
A8	XRA B
A9	XRA C
AA	XRA D
AB	XRA E
AC	XRA H
AD	XRA L
AE	XRA M
AF	XRA A
B0	ORA B
B1	ORA C
B2	ORA D
B3	ORA E
B4	ORA H
B5	ORA L
B6	ORA M
B7	ORA A
B8	CMP B
B9	CMP C
BA	CMP D
BB	CMP E
BC	CMP H
BD	CMP L
BE	CMP M
BF	CMP A
C0	RNZ
C1	POP B
C2	JNZ Adr
C3	JMP Adr
C4	CNZ Adr
C5	PUSH B
C6	ADI D8
C7	RST 0
C8	RZ
C9	RET Adr
CA	JZ
CB	- - -
CC	CZ Adr
CD	CALL Adr
CE	ACI D8
CF	RST 1
D0	RNC
D1	POP D
D2	JNC Adr
D3	OUT D8
D4	CNC Adr
D5	PUSH D
D6	SUI D8
D7	RST 2
D8	RC
D9	- - -
DA	JC Adr
DB	IN D8
DC	CC Adr
DD	- - -
DE	SBI D8
DF	RST 3
E0	RPO
E1	POP H
E2	JPO Adr
E3	XTHL
E4	CPO Adr
E5	PUSH H
E6	ANI D8
E7	RST 4
E8	RPE
E9	PCHL
EA	JPE Adr
EB	XCHG
EC	CPE Adr
ED	- - -
EE	XRI D8
EF	RST 5
F0	RP
F1	POP PSW
F2	JP Adr
F3	DI
F4	CP Adr
F5	PUSH PSW
F6	ORI D8
F7	RST 6
F8	RM
F9	SPHL
FA	JM Adr
FB	EI
FC	CM Adr
FD	- - -
FE	CPI D8
FF	RST 7

D8 = constant, or logical/arithmetic expression that evaluates to an 8 bit data quantity.

D16 = constant, or logical/arithmetic expression that evaluates to a 16 bit data quantity.

Fig. 10 Monitor Program Listing

```
                    ;IA7301  SYSTEM MONITOR ROUTINE, VERSION 1.0
                    ;JULY 1976
                    ;***********************************************
                     Copywrite 1978,  Entro, Incorporated. All rights
                     reserved. No part of this program may be reproduced,
                     transmitted, transcribed stored in a retrieval
                     system, or translated into any other language or
                     language, in any form by any means, electronic,
                     mechanical, optical, chemical,manual or otherwise
                     without prior written permission of Entro, Inc.,
                     1171 Borregas, Sunnyvale, California, 94086.
                    ;*****************************************************
0000                        ORG 0000H
0000                DISP0: DS 1
0001                DISP1: DS 1
0002                DISP2: DS 1
0003                DISP3: DS 1
0004                DISP4: DS 1
0005                DISP5: DS 1
0006                DISP6: DS 1
0007                DISP7: DS 1
0008                DIRG0: DS 1
0009                DIRG1: DS 1
000A                DIRG2: DS 1
000B                DIRG3: DS 1
000C                DIRG4: DS 1
000D                DIRG5: DS 1
000E                DIRG6: DS 1
000F                DIRG7: DS 1
0010                ACIMG: DS 1
0011                FGIMG: DS 1
0012                BIMG:  DS 1
0013                CIMG:  DS 1
0014                DIMG:  DS 1
0015                EIMG:  DS 1
0016                LIMG:  DS 1
0017                HIMG:  DS 1
0018                SPLIM: DS 1
0019                SPHIM: DS 1
001A                PCLIM: DS 1
001B                PCHIM: DS 1
8000                       ORG 8000H
8000 310001         INIT1: LXI SP, 0100H ;LOAD STACK POINTER
8003 C30680                 JMP INIT2
8006 3E00           INIT2: MVI A, 00H
8008 321800                STA SPLIM
800B 321A00                 STA PCLIM
800E 3E01                  MVI A, 01H
8010 321900                STA SPHIM
8013 321B00                 STA PCHIM
8016 213800                 LXI H, 0038H
8019 36C3                  MVI M, 0C3H ;LOAD RESTART 7
801B 2C                    INR L
801C 3628                  MVI M, STEP1 AND 00FFH
```

```
801E 2C              INR L
801F 3682            MVI M, STEP1 SHR 8
8021 3E10    DCM1:   MVI A, DASH ;KL0AD DIGIT 7 WITH
8023 CDCE80          CALL SUB5   ;DECEM AND REST
8026 210F00          LXI H, DIRG7;WITH DASHES.
8029 3612            MVI M, DECEM
802B CD3281  DCM2:   CALL C0NV1  ;SHIFT IN KEYS
802E CDF280          CALL KBDS0  ;INT0 ADDRESS
8031 CD4E81          CALL MDCCK  ;FIELD.
8034 FE12            CPI NEXT
8036 CA3F80          JZ DCM3
8039 CD7280          CALL SUB1B
803C C32B80          JMP DCM2

803F CDBC80  DCM3:   CALL SUB4   ;L0AD ADDRESS
8042 1A              LDAX D      ;DISPLAYS INT0
8043 CD9A80          CALL SUB3A  ;D AND E. M0VE
8046 CD3281  DCM4:   CALL C0NV1  ;MEM0RY INT0
8049 CDF280          CALL KBDS0  ;DISPLAYS 0 AND 1.
804C CD4E81          CALL MDCCK
804F FE12            CPI NEXT
8051 CA5A80          JZ DCM5
8054 CD6880          CALL SUB1A
8057 C34680          JMP DCM4

805A CDBC80  DCM5:   CALL SUB4   ;L0AD NEW
805D CD8C80          CALL SUB2A  ;INSTRUCTI0N INT0
8060 12              STAX D      ;MEM0RY, INCREMENT
8061 13              INX D       ;AND RETURN
8062 CDDE80          CALL SUB6
8065 C33F80          JMP DCM3
8068 E5      SUB1A:  PUSH H     ;SHIFTS DATA
8069 C5              PUSH B      ;INT0 DISPLAYS.
806A 210900          LXI H, DIRG1
806D 0E02            MVI C, 02H
806F C37E80          JMP SUB1D
8072 E5      SUB1B:  PUSH H
8073 C5              PUSH B
8074 210E00          LXI H, DIRG6
8077 0E04            MVI C, 04H
8079 C37E80          JMP SUB1D
807C E5      SUB1C:  PUSH H
807D C5               PUSH B
807E 0D      SUB1D:  DCR C
807F 2D              DCR L
8080 46              M0V B,M
8081 2C             INR L
8082 70              M0V M,B
8083 2D              DCR L
8084 0D              DCR C
8085 C27F80          JNZ SUB1D+1
8088 77              M0V M,A
8089 C1              P0P B
808A E1              P0P H
808B C9              RET
808C E5      SUB2A:  PUSH H     ;MERGES C0NTENT
808D C3B083          JMP 83B0H    ;0F TW0 DIS0PLAY
```

```
8090 E5         SUB2:    PUSH H        ;REGISTERS INTØ ACCUM.
8091 7E                  MØV A,M
8092 07                  RLC
8093 07                  RLC
8094 07                  RLC
8095 07                  RLC
8096 2D                  DCR L
8097 B6                  ØRA M
8098 E1                  PØP H
8099 C9                  RET
809A F5         SUB3A:   PUSH PSW    ;LØADS ACCUM
809B E5                  PUSH H      ;INTØ TWØ
809C C5                  PUSH B      ;DISPLAY REGISTERS.
809D 210900              LXI H, DIRG1
80A0 0E02                MVI C, 02H
80A2 C3A880              JMP SUB3C
80A5 F5         SUB3:    PUSH PSW
80A6 E5                  PUSH H
80A7 C5                  PUSH B

80A8 F5         SUB3C:   PUSH PSW
80A9 E6F0                ANI 0F0H
80AB 0F                  RRC
80AC 0F                  RRC
80AD 0F                  RRC
80AE 0F                  RRC
80AF CD7C80              CALL SUB1C
80B2 F1                  PØP PSW
80B3 E60F                ANI 0FH
80B5 CD7C80              CALL SUB1C
80B8 C1                  PØP B
80B9 E1                  PØP H
80BA F1                  PØP PSW
80BB C9                  RET
80BC E5         SUB4:    PUSH H
80BD 210C00              LXI H, DIRG4 ;LØADS DISPLAYS 3,4,5 AND 6
80C0 CD9080              CALL SUB2   ;INTØ D AND E REGISTERS.
80C3 5F                  MØV E,A
80C4 2C                  INR L
80C5 2C                  INR L
80C6 CD9080              CALL SUB2
80C9 57                  MØV D,A
80CA E1                  PØP H
80CB C9                  RET
80CC 3E11       SUB5A:   MVI A, BLANK ;BLANKS ALL DISPLAYS ØR

80CE E5         SUB5:    PUSH H       ;LØADS THEM ALL WITH
80CF C5                  PUSH B       ;SAME CHARACTERS.
80D0 211000              LXI H, DIRG7+1
80D3 0E08                MVI C,8
80D5 2D         SUB5B:   DCR L
80D6 0D                  DCR C
80D7 77                  MØV M,A
80D8 C2D580              JNZ SUB5B
80DB C1                  PØP B
80DC E1                  PØP H
80DD C9                  RET
```

```
80DE E5         SUB6:  PUSH H       ;LOADS CONTENTS OF D/E
80DF C5                PUSH B       ;REGISTERS INTO DISPLAY
80E0 210E00            LXI H, DIRG6 ;REGISTERS 3,4,5 AND 6.
80E3 7A                MOV A,D
80E4 0E02              MVI C,02H
80E6 CDA580            CALL SUB3
80E9 2D                DCR L
80EA 2D                DCR L
80EB 7B                MOV A,E
80EC CDA580            CALL SUB3
80EF C1                POP B
80F0 E1                POP H
80F1 C9                RET
80F2 C5         KBDS0: PUSH B
80F3 D5                PUSH D
80F4 E5                PUSH H
80F5 0E32              MVI C, BONCE

80F7 16CF       KBDS1: MVI D, KER07
80F9 210700            LXI H, DISP7
80FC 7E         KBDS2: MOV A,M      ;MOVE NUMBER
80FD 12         KBDS3:  STAX D      ;IN DISPLAY BUFFER
80FE 1A                LDAX D       ;TO ACCUM. SEND TO
80FF E640              ANI 40H      ;DISPLAY. READ KEYS.
8101 C2FE80            JNZ KBDS3+1  ;TEST FOR DISPLAY
8104 1A                LDAX D       ;ONE SHOT.RELOAD ACCUM
8105 EE07              XRI 07H      ;WITH KEYS. COMPARE KEY
8107 E60F              ANI 0FH      ;IMAGE. KEY CLOSURE NOW
8109 C21A81            JNZ KBDS5    ;=1, IF KEY FOUND, GO TO
810C 0D                DCR C        ;KBDS5. DECREMENT BOUNCE
810D C21181            JNZ KBDS4    ;COUNTER IF 0, INC AND PASS
8110 0C                INR C        ;ON TO KBDS4. IF NOT 0,

8111 15         KBDS4: DCR D        ;GO STRAIGHT TO KBDS4.
8112 15                DCR D        ;DECREMENT POINTERS.
8113 2D                DCR L
8114 FAF780            JM KBDS1
8117 C3FC80            JMP KBDS2
811A 0D         KBDS5: DCR C     ;IF BOUNCE COUNTER IS 0,
811B CA2481            JZ KBDS6     ;PROCESS KEY. IF NOT,
811E 0E32              MVI C, BONCE;RELOAD COUNTER.
8120 00C31181         JMP KBDS4
8124 E63E       KBDS6: ANI 3EH      ;ZERO OUT LSB.
8126 07                RLC          ;ROTATE LEFT TWICE.
8127 07                RLC          ;BRING ROW COUNT TO ACCUM
8128 5F                MOV E,A      ;AND OR WITH COLUMN IMAGE.
8129 7A                MOV A,D
812A E60E              ANI 0EH      ;EXIT WITH 8-BIT NUMBER
812C 0F                RRC          ;IN ACCUM. 4 LSB ARE
812D B3                ORA E        ;HEX KEYS . BIT #4 IS
812E E1                POP H        ;MODE KEY, #5 IS STEP KEY,
812F D1                POP D        ;AND 6 AND 7 ARE DIP
8130 C1                POP B        ;SWITCH INPUTS.
8131 C9                RET
8132 C5         CONV1: PUSH B       ;CONVERT FOUR BIT BINARY
8133 D5                PUSH D       ;NUMBER IN DISPLAY  REGISTERS
8134 E5                PUSH H       ;TO 7-SEGMENT CODES.
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8135 F5                PUSH PSW    ;IN DISPLAY BUFFERS.
8136 010700            LXI B, DISP7
8139 110F00            LXI D, DIRG7

813C 218282    CØNV2:  LXI H, SSEG4
813F 1A                LDAX D
8140 85                ADD L
8141 6F                MØV L,A
8142 7E                MØV A,M
8143 02                STAX B
8144 1D                DCR E
8145 0D                DCR C
8146 F23C81            JP CØNV2
8149 F1                PØP PSW
814A E1                PØP H
814B D1                PØP D
814C C1                PØP B
814D C9                RET
814E 5F        MDCCK:  MØV E,A     ;CHECKS CØNTENTS ØF ACCUM
814F 33                INX SP      ;TØ SEE IF MØDE HAS BEEN
8150 33                INX SP      ;CHANGED.
8151 07                RLC
8152 07                RLC
8153 07                RLC
8154 DA0182            JC EXEC1    ;STEP KEY
8157 07                RLC
8158 7B                MØV A,E
8159 D27581            JNC MDCC1
815C E607              ANI 07H
815E CA2180            JZ DCM1     ;DCM MØDE
8161 3D                DCR A
8162 CA7981            JZ DCR1     ;DCR MØDE
8165 3D                DCR A
8166 CA7581             JZ MDCC1    ;ESCAPE FØR NEXT
8169 3D                DCR A
816A CA0182            JZ EXEC1    ;EXECUTE MØDE
816D 3D                DCR A
816E CA9B82             JZ TAPW     ;WRE TAPE
8171 3D                 DCR A
8172 CA1783             JZ TAPR     ;READ TAPE

8175 7B        MDCC1:  MØV A,E
8176 3B                DCX SP
8177 3B                DCX SP
8178 C9                RET
8179 3E10      DCR1:   MVI A, DASH
817B CDCE80            CALL SUB5
817E 210F00            LXI H, DIRG7
8181 3613              MVI M, DECER
8183 011000            LXI B, ACIMG
8186 217382            LXI H, SSEG1
8189 7E        DCR1A:  MØV A,M    ;TEST FØR END ØF TABLE.
818A B7                 ØRA A      ;MARKER. TEST FØR TWØ
818B CA7981             JZ DCR1    ;BYTE ENTRY. IF NØT,
818E 35                 DCR M      ;CALL DCR5.
818F CAB281             JZ DCR2    ;
8192 CDF881             CALL DCR5
```

```
8195 CD3281   DCR3:  CALL C0NV1  ;DISPLAY AND SHIFT
8198 CDF280          CALL KBDS0  ;NEW DATA INT0
819B CD4E81          CALL  MDCCK ;DISPLAYS 0 AND 1.
819E FE12            CPI NEXT
81A0 CAA981          JZ DCR4
81A3 CD6880          CALL SUB1A
81A6 C39581          JMP DCR3

81A9 CD8C80   DCR4: CALL SUB2A
81AC 02                STAX B
81AD 23          INX H        ;INCREMENT AND RETURN.
81AE 03               INX B
81AF C38981           JMP DCR1A
81B2 23       DCR2:   INX H        ;F0UND A TW0 BYTE
81B3 CDF881          CALL DCR5    ;INDICAT0R . GET NEXT
81B6 23               INX H        ;SYMB0L AND L0AD INT0
81B7 03               INX B        ;DIRG5. GET HIGH 0RDER
81B8 7E              M0V A,M      ;BYTE AND L0AD INT0 DIRG1.
81B9 320D00          STA DIRG5
81BC 0A              LDAX B
81BD E5                PUSH H
81BE C5                PUSH B
81BF 210B00            LXI H, DIRG3
81C2 0E02              MVI C, 02H
81C4 CDA580            CALL SUB3
81C7 C1                P0P B
81C8 E1                P0P H
81C9 CD3281   DCR6:  CALL C0NV1  ;DISPLAY TW0 BYTES
81CC CDF280          CALL KBDS0  ;0F DATA AND L0AD
81CF CD4E81          CALL MDCCK  ;AND SHIFT IN KEYS.
81D2 FE12            CPI NEXT
81D4 CAE681          JZ DCR7
81D7 E5              PUSH H
81D8 C5              PUSH B
81D9 210B00            LXI H, DIRG3
81DC 0E04              MVI C, 04H
81DE CD7C80            CALL SUB1C
81E1 C1                P0P B
81E2 E1                P0P H
81E3 C3C981            JMP DCR6
81E6 CD8C80   DCR7: CALL SUB2A
81E9 0B                DCX B
81EA 02                STAX B
81EB E5                PUSH H
81EC 210B00            LXI H, DIRG3
81EF CD9080            CALL SUB2
81F2 E1                P0P H
81F3 03                INX B
81F4 02                STAX B
81F5 C3AD81            JMP DCR4-4
81F8 7E       DCR5:  M0V A,M      ;L0AD SYMB0L INT0
81F9 320E00          STA DIRG6    ;DIRG6 AND IMAGE INT0
81FC 0A              LDAX B       ;DIRG0.
81FD CD9A80            CALL SUB3A
8200 C9              RET
8201 210060   EXEC1: LXI H, 6000H
8204 36F7              MVI M,0F7H
8206 2A1800            LHLD SPLIM
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8209 F9                  SPHL
820A 2A1A00              LHLD PCLIM
820D E5                  PUSH H
820E 211000            LXI H, ACIMG
8211 3E03              MVI A,03H
8213 00       EXEC2:   N0P
8214 56                M0V D,M
8215 23                INX H
8216 5E                M0V E,M
8217 23                INX H
8218 D5                  PUSH D
8219 3D                  DCR A
821A C21382              JNZ EXEC2
821D 00                N0P
821E 5E                  M0V E,M
821F 23                  INX H
8220 56                  M0V D,M
8221 D5                  PUSH D
8222 E1                  P0P H
8223 D1                  P0P D
8224 C1                  P0P B
8225 F1                  P0P PSW
8226 FB                  EI
8227 C9                  RET
8228 221600     STEP1: SHLD LIMG
822B F5                 PUSH PSW
822C 211200            LXI H, BIMG
822F 70                M0V M,B
8230 2C                INR L
8231 71                M0V M,C
8232 2C                INR L
8233 72                M0V M,D
8234 2C                INR L
8235 73                M0V M,E
8236 D1                P0P D
8237 C3C083            JMP 83C0H
823A E1                 P0P H
823B 221A00             SHLD PCLIM
823E 210000             LXI H,0
8241 39                 DAD SP
8242 221800             SHLD SPLIM
8245 16CF       STEP1A: MVI D,KER07
8247 1A                  LDAX D
8248 E608                ANI 08H
824A C24582              JNZ STEP1A
824D 210060     STEP2: LXI H,6000H
8250 36FF                MVI M,0FFH
8252 3E10                MVI A,DASH
8254 CDCE80            CALL SUB5
8257 210F00            LXI  H, DIRG7
825A 3614              MVI M, STEP
825C 2A1A00            LHLD PCLIM
825F EB                XCHG
8260 CDDE80            CALL SUB6
8263 1A                LDAX D
8264 CD9A80            CALL SUB3A
8267 CD3281     STEP3: CALL C0NV1
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826A CDF280             CALL KBDS0
826D CD4E81             CALL MDCCK
8270 C36782             JMP STEP3

8273 0A0F0B0C SSEG1: DB 0AH, 0FH, 0BH, 0CH, 0DH
8277 0D
8278 0E171801           DB 0EH, 17H, 18H, 01H, 05H
827C 05
827D 1601160C           DB 16H, 01H, 16H, 0CH, 00H
8281 00
8282 C0F9A4B0 SSEG4: DB 0C0H, 0F9H, 0A4H, 0B0H, 99H
8286 99
8287 9282F880 SSEG5: DB 92H, 82H, 0F8H, 80H, 90H
828B 90
828C 8883C6A1 SSEG6: DB 88H, 83H, 0C6H, 0A1H, 86H
8290 86
8291 8EBFFFAB SSEG7: DB 8EH, 0BFH, 0FFH, 0ABH, 0E3H
8295 E3
8296 8F7F8CC7           DB 8FH, 7FH, 8CH, 0C7H, 89H
829A 89
00CF                 KERO7 EQU 0CFH
0032                 BONCE EQU 32H
0010                 DASH EQU 10H
0012                 DECEM EQU 12H
0014                 STEP EQU 14H
0013                 DECER EQU 13H
0011                 BLANK EQU 11H

               ;AUDIO TAPE R/W PROGRAM
               HILO   EQU 3D9FH  ;INC HL RTN W CY=1 IF GT DE

829B D5        TAPW:  PUSH D      ;SAVE END ADD.
829C C3D083           JMP 83D0H   ;SAVE START ADD.
829F 113500           LXI D,35H   ;PERIOD & # CYCLES
82A2 0600             MVI B,0     ;LEADER COUNTER THEN CHECK SUM
82A4 CD0683    LEADR: CALL FREQ   ;WRITE LEADER
82A7 05               DCR B       ;COUNT LEADER
82A8 C2A482           JNZ LEADR
82AB E1               POP H
82AC D1               POP D       ;RESTORE START AND END ADD.
82AD 7C               MOV A,H     ;WRITE START ADD. ON TAPE
82AE CDD382           CALL TAPX   ;WRITE WORD AND ADD TO CHECK SUM
82B1 7D               MOV A,L
82B2 CDD382           CALL TAPX
82B5 7A               MOV A,D     ;WRITE STOP ADD. ON TAPE
82B6 CDD382           CALL TAPX
82B9 7B               MOV A,E
82BA CDD382           CALL TAPX
82BD 7E        TAPW1: MOV A,M  ;WRITE DATA ON TAPE
82BE CDD382         CALL TAPX
82C1 CDA183         CALL HILO  ;INC HL AND TEST GT DE
82C4 D2BD82         JNC TAPW1  ;DO AGAIN IF NO CARRY
82C7 AF             XRA A      ;CLEAR ACC
82C8 90             SUB B      ;GET CHECK SUM
82C9 CDD382         CALL TAPX
82CC 2660     EXIT: MVI H, 60H ;READ OR WRITE EXIT
82CE 36FF           MVI M,0FFH ;TURN TAPE OFF
82D0 C32180         JMP DCM1
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82D3 4F        TAPX: MOV C,A    ;SAVE IN C
82D4 80              ADD B
82D5 47              MOV B,A    ;ADD TO CHECK SUM
82D6 C5              PUSH B
82D7 D5              PUSH D
82D8 E5              PUSH H
82D9 2660            MVI H,60H  ;ESTABLISH I/O ADD.
82DB 79              MOV A,C    ;GET WORD TO WRITE INTO A
82DC B7              ORA A      ;CLEAR CARRY
82DD 010309          LXI B,0903H ;BIT COUNTERS 1 START 8 DATA 2 STOP
82E0 CD0383     BYTE1: CALL HIF ;WRITE HI FREQ. TONE
82E3 DC0383          CC HIF     ;LONG HI FREQ. TONE IF CY.= 1
82E6 D4FD82          CNC LOF    ;TERMINATE WITH LO FREQ. TONE
82E9 CDFD82          CALL LOF   ;TERMINATE WITH LO FREO. TONE
82EC 05              DCR B      ;COUNT NUMBER OF BITS
82ED FAF582          JM BYTE2   ;STOP BITS F MINUS
82F0 IF              RAR        ;GET NEXT BIT TO WRITE INTO CY.
82F1 C2E082          JNZ BYTE1  ;IF B GT 0 WRITE ANOTHER DATA BIT
82F4 37              STC        ;IF B = 0 SET CY TO WRITE STOP BITS
82F5 0D       BYTE2: DCR C      ;COUNT NUMBER OF STOP BITS
82F6 C2E082          JNZ BYTE1  ;IF NOT 0 WRITE ANOTHER STOP BIT
82F9 E1              POP H
82FA D1              POP D
82FB C1              POP B
82FC C9              RET        ;DONE WITH ONE BYTE
82FD 113508     LOF: LXI D,0835H ;LOW FREQ. FOR 4 CYCLES
8300 C30683          JMP FREQ
8303 111A10          LXI D,101AH ;HIGH FREQ. FOR 8 CYCLES
8306 F5        FREQ: PUSH PSW
8307 3EFB            MVI A,OFBH  ;TAPE ON BIT 1 FREQ. BIT 0
8309 EE01    FREQ2:  XRI 1      ;TOGGLE FREQ. OUTPUT
830B 77              MOV M,A    ;OUTPUT
830C 6B              MOV L,E    ;SET PERIOD COUNTER
830D 2D    FREQ1:    DCR L      ;COUNT PERIOD
830E C20D83          JNZ FREQ1
8311 15              DCR D      ;COUNT # OF PERIODS
8312 C20983          JNZ FREQ2
8315 F1              POP PSW
8316 C9              RET
8317 2660      TAPR: MVI H,60H  ;START OF TAPE READ
8319 C3E583          JMP 83E5H
831C 73              MOV M,E    ;TURN ON TAPE
831D AF         WA3: XRA A
831E B6         WA1: ORA M
831F F21E83          JP WA1     ;WAIT FOR
8322 A6         WA2: ANA M      ;3002H CHANGES ON TAPE
8323 FA2283          JM WA2
8326 1B              DCX D
8327 7A              MOV A,D
8328 B3              ORA E
8329 C21D83          JNZ WA3
832C 0600            MVI B,0    ;CLEAR CHECK SUM
832E CD4E83          CALL TAPY  ;GET START ADD.
8331 61              MOV H,C
8332 CD4E83          CALL TAPY
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8335 69             MØV L,C
8336 CD4E83         CALL TAPY  ;GET STØP ADD.
8339 51             MØV D,C
833A CD4E83         CALL TAPY
833D 59             MØV E,C
833E CD4E83    TAPR1: CALL TAPY ;START READING DATA
8341 71             MØV M,C
8342 CDA183         CALL HILØ  ;INC HL AND TEST FØR GT DE
8345 D23E83         JNC TAPRI
8348 CD4E83         CALL TAPY  ;READ CHECK SUM
834B C3EE83         JMP 83EEH  ;END ØF TAPE READ
834E E5        TAPY:  PUSH H   ;READ BYTE FRØM TAPE
834F D5             PUSH D
8350 C5             PUSH B
8351 26C0           MVI H,C0H   ;SET I/Ø ADD,
8353 06FF      TAPY1: MVI B,0FFH ;FLAG WAIT FØR START BIT
8355 1E03     RBIT3: MVI E,3   ;ØF HI FREQ PERIØDS
8357 1638     RBIT4: MVI D,38H ;PERIØD CØNSTANT
8359 AF             XRA A
835A 15          CX1:  DCR D   ;MEASURE TIME BETWEEN
835B B6             ØRA M      ;0 TØ 1 CHANGE IN D
835C F25A83         JP CX1     ;WAIT FØR ZERØ
835F 15          CX2:  DCR D
8360 A6             ANA M
8361 FA5F83         JM CX2    ; WAIT FØR ØNE
8364 15             DCR D      ;SET FLAGS, CHANGE HAPPEN
8365 FA5583         JM RBIT3   ;LØNG PERIØD IF MINUS
8368 1D             DCR E      ;DEC. IF SHØRT PERIØD
8369 F25783         JP RBITA   ;IF PØS. NØT ENØUGH SHØRT ØNES
836C 3E00           MVI A,00H   ;DELAY UNTIL END ØF HI FREQ
836E 3D             RBIT5: DCR A
836F C26E83         JNZ RBIT5
8372 1105D8         LXI D,0D805H ;CØUNT # ØF CHANGES IN A FIXED
8375 CD9083         CALL CT    ;D = TIME, E = 1/0 THRESHØLD
8378 7B             MØV A,E    ;ØNE IF E HAS GØNE NEG.
8379 17             RAL        ;CY = BIT VALUE
837A 05             DCR B      ;DEC. BIT CØUNTER
837B F28383         JP RBIT8   ;IF PØS. INSERT BIT INTØ C
837E DA5383         JC TAPY1   ;JUMP IF NØ START BIT
8381 0608           MVI B,8    ;IF START, SET TØ # ØF BITS
8383 79       RBIT8: MØV A,C   ;INSERT BIT INTØ C
8384 1F             RAR
8385 4F             MØV C,A
8386 C25583         JNZ RBIT3  ;JUMP TØ GET NEXT BIT
8389 C1             PØP B      ;GET CHECK SUM
838A 4F            MØV C,A     ;SAVE BYTE IN C
838B 80             ADD B      ;ADD TØ CHECK SUM
838C 47             MØV B,A
838D D1             PØP D
838E E1             PØP H
838F C9             RET
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8390 AF          CT:   XRA A      ;COUNT 0 TO 1 CHANGES FOR A
8391 15         CT1:   DCR D      ;FIXED TIME SPECIFIED BY D
8392 C8                RZ         ;RETURN WHEN D = 0
8393 B6                ORA M
8394 F29183            JP CT1     ;WAIT FOR ZERO
8397 15         CT2:   DCR D
8398 C8                RZ
8399 A6                ANA M
839A FA9783            JM CT2     ;WAIT FOR ONE
839D 1D                DCR E      ;COUNT CHANGE
839E C39083            JMP CT     ;KEEP GOING
83A1 23        HILO:   INX H
83A2 7B                MOV A,E
83A3 95                SUB L
83A4 7A                MOV A,D
83A5 9C                SBB H
83A6 C9                RET
83B0 210900            LXI H,DIRG1
83B3 C39180            JMP 8091H
83C0 63                MOV H,E
83C1 6A                MOV L,D
83C2 221000            SHLD 0001H
83C5 E1                POP H
83C6 221A00            SHLD 001AH
83C9 C33E82            JMP 823EH
83D0 2A1400            LHLD 0014H
83D3 55                MOV D,L
83D4 5C                MOV E,H
83D5 2A1600            LHLD 0016H
83D8 D5                PUSH D
83D9 E5                PUSH H
83DA 2660              MVI H,60H
83DC C39F82            JMP 829FH
83E5 11FD30            LXI D,30FDH
83E8 73                MOV M,E
83E9 26C0              MVI H,0C0H
83EB C31C83            JMP 831CH
83EE CACC82            JZ 82CCH
83F1 3E0E              MVI A,0EH
83F3 C32380            JMP 8023H
0000                   END
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